

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) COLLAGEN-COATED FOODSTUFFS, PARTICULARLY SAUSAGES

- (71) We, UNILEVER LIMITED, a company registered under the laws of Great Britain, of Port Sunlight, Berkenhead, Cheshire, England, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- The invention relates to the preparation of collagen-coated foodstuffs, especially sausages.
- There are two approaches to making of sausages. The first is to take natural or artificial sausage casing and stuff it with sausage meat and the second is to shape the sausage meat and then apply a material forming a coating or casing. The more fundamentally satisfactory approach is the second since it allows one to make the sausage in what is basically a continuous process. Intermediate stages of preparation and storage of casing and its filling with sausage meat are then avoided. However the economic and practical problems of the second approach have not been solved hitherto.
- We have now found that collagen-coated foodstuffs, particularly sausages, can be made by a process in which a collagen dough is extruded in tubular form upon a foodstuff and the collagen coating so formed is stabilised, one or both surfaces of the collagen being subjected during extrusion to frictional forces acting in a direction about the axis of extrusion. The frictional forces are conveniently applied by relative rotational movement between inner and outer members of a die through which the collagen dough is being extruded. Preferably the movement is provided by rotation of the inner and outer members of the die in opposite senses.
- In a particularly preferred process sausage meat or other extrudable foodstuff is shaped to receive the collagen by extrusion simultaneously with it, for example through an axial bore in the inner member of the die mentioned above. The bore is conveniently of the same cross-section as the food product being prepared.
- The collagen can be set by methods known in themselves in the preparation of artificial sausage casing. Conveniently extrusion takes place into a setting bath, containing for example common salt brine. Under the influence of the setting solution the collagen is coagulated, precipitated or set in contact with the extruded foodstuff and the formed length of coated foodstuff then emerges from a bath to undergo any further process steps required. Stabilisation may however be by other means.
- It is believed that the application of the frictional forces orients the collagen fibres in the dough in such a way that the strength of the coating or casing is satisfactorily in all directions even when the coating is very thin and therefore tender to eat. The coating produced by the contra-rotating die is for example believed, from optical examination of coatings produced by the detailed method described later, to have substantially all the fibres oriented. Fibres appear during extrusion to come under the influence of either the forces exerted by the one die or those exerted by the other, so that the fibres adjacent to one surface of the coating are aligned in one direction and these adjacent to the other surface are aligned in a different direction. There appear to be substantially no fibres of an intermediate orientation. The angle included between the fibres in the direction of the axis of extrusion has been measured in different samples from the contra-rotating die extruder, all giving good cooking results, at 51° to 96°, varying with the speed of rotation of the die members and with the other conditions. A wider range of angles, for example 30° to 120° is possible. Lining up of the fibres in the direction of extrusion such as occurs in simple extrusion with fixed dies and leads to splits in the product is avoided and the control achieved over orientation of the fibres is in contrast with processes where

collagen is applied to formed sausages by spray or dip.

Where a die with a rotating inner member having an axial bore is used the sausage meat or other foodstuff advantageously passes through a tube inserted in the bore to isolate the foodstuff from moving parts. Such a tube can be virtually the same size as the product so that, for example, sausage meat does not have to be forced through a narrow-bore tube inserted in a shirred casing (which is necessarily of narrower diameter than non-shirred casing), and then be filled into the casing, with attendant mechanical working. The tube is ordinarily circular in internal shape giving a product of circular cross-section but products of other shapes can be produced if the tube is appropriately shaped, and such products, or those extruded in circular form, can be further shaped after extrusion. Shapes rectangular in section, for example beefburgers, can then be provided. If the tube is not circular internally there will be a considerable gap between the foodstuff and the collagen at the moment of extrusion but the combined effect of the dehydrating action of the setting solution and its hydrostatic pressure (a bath is conveniently used) the relative speeds of extrusion of collagen dough and foodstuff, and any subsequent drying, will give a coating conforming closely to the shape of the foodstuff. Modification of the shape of the product, for example by rolling, is desirably carried out before the drying. For the beefburgers a collagen-coated ribbon of beefburger mix is extruded, and then rolled if required, before cutting into separate beefburgers and drying.

Sausages for smoking, for example frankfurters, may be made by the process of the invention, as the present process permits very thin coatings. Pre-formed artificial casing is liable to become unacceptably tough on smoking.

The process steps subsequent to the setting of the collagen may be varied as required. Usually the product will require drying or other steps to bring the collagen from the set but still wet condition to a stable, handleable state. The casing may for example be tanned using such agents as formaldehyde, liquid smoke extracts, alum and di-aldehyde alginic acid. The production of this last agent is described in the applicant's U.K. patent specification No. 1,109,509.

In a particularly convenient process according to the invention the coated foodstuff after setting of the collagen in a salt setting solution is simply dried in the presence of the salt taken up from the setting solution, preferably by forced blast air drying. Provided an edible setting salt is used it is unnecessary to remove it in separate washing stages followed by drying stages, such as are required in the preparation of artificial casing to be

used in the conventional manner. It has been found that, particularly when the foodstuff is sausage meat, the salt in the coating migrates into the foodstuff during processing and storage. The final coating has very satisfactory physical and eating properties.

The foodstuff may be cut into individual portions shortly after setting of the collagen or it may be treated as a continuous length and cut later.

When the foodstuff coated is a meat product the extrusion of collagen onto the foodstuff and the subsequent setting and, desirably, drying causes an interaction of the collagen of the casing with the meat components of the foodstuff and gives a coating, corresponding in function to the casing of ordinary sausages, which is tender to eat but nevertheless of excellent strength and other properties.

This coating differs from the casing on sausages made by the conventional stuffing procedures in that once drying has taken place the coating is to a degree part of the meat and cannot for example readily be stripped from it. If the coating is removed the outer layer of the meat comes off with it, in contrast to ordinary artificial casing. Differential shrinkage during cooking with extrusion of the meat can be reduced as compared with ordinary casing or even eliminated.

In the process of the invention the raw materials are collagen dough and, for example, pork or beef sausage meat. The preparation of the foodstuff is entirely conventional, and is not described here.

The collagen dough also can be prepared by processes known in themselves. It is preferred that the collagen used to make the dough should have been pre-treated to break down partially the organised structure in the original native animal tissue used, for example hide or tendon, and render the collagen more soluble. There are various such processes, including enzyme treatments, but a preferred one is the treatment with alkali in the presence of salt described in our U.K. patent specification No. 1,082,852.

The viscosity of the collagen dough for use in the process of the invention is preferably 45 to 90 poise, most advantageously 60 to 70 poise, to obtain the best qualities in the product. The collagen solids content is correspondingly preferably 4.3 to 7.4%, most advantageously 5.2 to 5.8%. The extractability (as defined below) of the collagen used to make the dough is preferably 7 to 16 advantageously about 9.

The extractability is a measure of the breakdown of the native insoluble collagen matrix to give soluble material, and is defined as the proportion of a given collagen sample that is acid-soluble, as determined by any suitable method. Such a method is of course conveniently solution in an aqueous solution of an acid, for example 0.15 M acetic

acid, but any other method that directly or indirectly gives an indication of the proportion of the sample that is in fact acid-soluble can be used. The solubility has reference to single tropocollagen molecules, the fundamental building units of collagen; their molecular weight is about 300,000.

The extractability of collagen for the purposes of the numerical preferences given herein is defined as the weight percentage of a 1.5 g. samples of milled collagen, pressed free of superficial moisture, taken up after 12 hours soaking at 20°C in 100 ml. 0.15 M aqueous acetic acid, and remaining in solution after centrifugation for 1/2 hour at 27,000 g. any precipitate being discarded followed by filtration of the supernatant through a sintered filter of porosity No. 3. The amount of collagen in the supernatant may be determined by any convenient standard method, for example hydroxyproline analysis or the modified Biuret reaction, and is calculated as dry weight. The percentage is related to the dry weight collagen content of the sample. To determine this a sample conveniently 5.0 g. is dried to constant weight at 105°C. Fat and ash may be ignored in good collagen low in them if a preliminary determination has confirmed that they are indeed low.

The extractability is conveniently determined on the batch concerned since treated collagen can readily be held in store and in practice is so held to give a manufacturing 'float'. However, if the raw material is uniform enough the extractability can be determined by reference to a record of the value for a similar earlier batch, similarly treated, or can simply be assumed to be satisfactory.

The pre-treatment for the collagen described in our earlier U.K. patent specification No. 1,082,852 is to soak the collagen in the form of pieces of hide split for example, in saturated or nearly saturated (preferably over 90% saturated for a few hours, until it is uniformly impregnated, then to soak in a similar solution containing sodium hydroxide, preferably at a pH above 13, until the desired extractability is reached, the time required being found by simple experiment. The sodium sulphate prevents swelling of the collagen, which is not desired at this stage. Common salt is also effective as an anti-swelling agent and so also are other alkali metal salts, for example potassium sulphate and potassium chloride. The time required is dependent on the conditions for example the temperature and the concentration of the sodium hydroxide. When for example sodium sulphate is being used and the temperature is 20°C about 20 hours is sufficient in 1 N sodium hydroxide. Where sodium chloride is used as the anti-swelling salt the time required at a given concentration of alkali is

increased, for example at 1 N and 20°C to 24 to 36 hours, with an optimum of 30 hours.

If the normality of the sodium hydroxide is increased the time required is reduced, the limit being believed to be set by the permeability of the collagen; excessively concentrated alkali overtreats and damages the outer part of a piece of collagen while not permeating sufficiently to treat the interior adequately.

After treatment the collagen is neutralised by soaking in acid, and washed. Its extractability is then determined if necessary, that is to say if the starting material is not such that the extractability can be assumed to be satisfactory. A batch of low extractability can be re-treated; one of over-high extractability is preferably discharged but can be mixed with later batches if desired.

While the extractability cannot readily be changed once the collagen has been milled in preparation for making the dough, it is easy to adjust the solids content by addition of water to give a viscosity in the final dough within the preferred range already noted. Process variations and variations in the starting material can therefore be allowed for, provided the extractability is within the given range. The solids content is readily determined for control purposes by analysis or for example by comparison of the weight of a given air-free volume sample with that of the same volume of water. Tables giving the solids content for a given weight ratio can be drawn up from a knowledge of the densities of collagen and water.

We do not limit the application of the invention by the following theory of the effect of alkali treatment where used but we believe the viscosity of the dough to be broadly a function of the concentration of collagen fibres in the dough and accordingly a heavily alkali-treated collagen, with few fibres, can give a high enough viscosity if the dough is of high total solids content, while a lightly alkali-treated collagen can give a low enough viscosity if the dough is of low total solids content. In each case the coating produced is believed to have about the same number of fibres in a given area and is of the desired properties. In general, whatever collagen is used, too many fibres are believed to give a coating tough to eat and liable to splits in the pan and too few a weak one, liable to bubbling.

In the preparation of the dough acid swelling of the collagen is preferred. When it is used the final pH of the dough is preferably 2.8 to 3.5, more preferably 2.9 to 3.1. Suitable acid swelling agents are well known in themselves. Organic hydroxy acids are examples, in particular citric acid and lactic acid, of which the latter is preferred. Where alkaline swelling is used, effected by for ex-

ample caustic soda, the final pH is preferably 11.5 to 12.2, advantageously 11.8 to 12.1. The following gives details of the conditions during the co-extrusion and subsequently.

The setting solution preferably contains a salt for example common salt brine 50 to 100% saturated, preferably over 75% saturated. It may, when an acid swollen dough is used, also contain sufficient ammonia to be about N/10 with respect to ammonium hydroxide; the pH of such a solution is between 10 and 12. The action of the setting bath by withdrawal of water is then assisted by neutralisation of the acid, indeed setting is possible by neutralisation alone. Other setting solutions, for example ammonium sulphate solution, are suitable but not preferred since washing to remove material taken up in the bath may be necessary. Other salts also are suitable, provided they are not taken up by the product in amounts which effect its edibility and cannot, if necessary, be removed. Non-toxic salts are for example sodium sulphate, di-sodium hydrogen phosphate, trisodium phosphate, trisodium citrate and corresponding potassium salts. There are also organic-solvent setting liquids, for example methanol/ammonia. A setting bath is conveniently used and the required depth, found by simple experiment, varies according to the time required to impart the necessary strength to the collagen, and accordingly also with the extrusion speed. At an extrusion speed of 25 ft/min. (12 cm./sec.) a setting bath depth of 12 inches (30 cm.) is sufficient, giving a residence time of 2.4 seconds. Shorter residence times are possible however and in any case the setting solution continues to act during the draining that takes place after the product has left the bath. The dough is extruded at a speed consistent with the rate of extrusion of the foodstuff, generally at the same speed. If desired however the foodstuff, sausage meat for example, can be extruded slightly faster than the dough, to give some draw-down, that is to say stretching and if required narrowing of the extruded collagen.

The chosen rate of extrusion can vary over a considerable range, from rates as low as 5 or 6 feet/min. (2.5 cm./sec.) up to 45 feet/min. (22 cm./sec.) or more speeds up to 100 ft./min. (50 cm./sec.) or more. The thickness of the coating at a given rate of extrusion of the foodstuff can be varied by varying the volume rate at which the collagen dough is extruded. The corresponding thickness of the coating is not easy to measure because of the combination with the foodstuff that takes place and the softness and flexibility of the coating but is for example ordinarily about 4 thousandths of an inch (ca. 0.1 mm.) after drying to approximately 40% water content. In the case of chipolata sausages for example the rate of collagen extrusion is pre-

ferably such as to give between 4 and 10 grams of the set but still wet collagen per foot of product (ca. 13—33 g./metre) for chipolatas of 0.72" (1.8 cm.) diameter. Such a weight per foot corresponds to a thickness of about 9 to 23 thousandths of an inch in the set but still wet casing. This thickness is reduced from the thickness of the extruded collagen dough by the action of the setting solution. The actual thickness depends on the size of the gap through which the collagen dough is extruded and on the volume rate of extrusion. Suitable rates for other products are readily found by simple trial. It is a considerable advantage of the invention that only about 60% of the collagen required to make a corresponding length of artificial casing need be used, and this is on top of the saving in avoiding twist linking, as mentioned elsewhere. The actual extrusion pressure is chosen according to the plant in use; pressure of 80 to 120 p.s.i. (5.5 to 8.5 kg./sq.cm.) are for example suitable with a stuffer of the kind used for sausage meat.

The temperature of the dough and setting solution can be ordinary ambient factory temperature, say 15° to 25°C or the dough or both the dough and the setting solution may be chilled. Low temperatures may however increase the viscosity of the dough without compensating advantage, while higher ones may have a bad effect on the collagen. A temperature of 40°C is preferably not exceeded, since higher temperatures may deleteriously affect the properties of the collagen. The extruder itself is preferably, according to the invention, a contra-rotating die extruder, particularly one having contra-rotating cones between which the dough passes, as described below. The preferred gap between the cones is 15 to 20 thousandths of an inch (0.35 to 0.5 mm.), but other gaps, for example between 10 and 25 thousandths of an inch (0.25 to 0.60 mm.) can be used. The cones of the extruder are preferably rotated at the same speed as each other or with up to 30 r.p.m., for example 10 or 15 r.p.m., difference. Various speeds of rotation can be used, for example 60 to 120 r.p.m. If only one cone is rotated its speed should be higher, preferably high enough to give the same relative speed of 120 to 240 r.p.m., for example 155 r.p.m.

In the case of sausages the length of sausage is preferably 'crimped' or otherwise shaped by pushing aside the sausage meat within the casing to define individual sausages, directly after the extrusion, that is to say before any drying. The sausages can be cut apart then or later. In drying conditions may vary but at an air temperature of 15 to 25°C and an absolute humidity of up to about 0.012 (12 g. water per kg. dry air), an air speed of 2,000 ft./min. (10 to 15 m/sec.) is suitable. Ambient humidity in the

United Kingdom is not usually above 0.009 (9 g/kg.). Such an air speed gives drying in a sufficiently short time for the length of drying conveyor necessary to be manageable, using ambient air, but if the air is warmed for lower speeds, for example down to 300 ft./min (1.5 m/sec.) may be used. Further advantages may be gained by dehumidifying the air. The air temperature is preferably not above about 45°C for English sausages since there is a tendency for the meat to be discoloured and for melting of the fat to occur in the sausage meat at higher temperatures, and a product of lower quality is produced. This tendency is accentuated near the end of the drying when less water is evaporating from the product and the resulting cooling effect is less.

The progress of the drying of sausages may be followed by attempting to remove the coating or casing. Drying has reached an acceptable degree when the casing can be no longer removed cleanly but brings the meat with it. It is however desirable to dry further. The moisture content of the coating after leaving the setting solution is generally some 80 or 85%. Drying is preferably carried out until a 50% moisture content, and advantageously until a 40% moisture content, is reached. During equilibrium of moisture content between foodstuff (sausage meat) and coating the moisture content rises again, to some 65 to 75%.

The actual residence time required in the drier is determined by simple experiment on the equipment in use and is a function of air velocity, temperature, humidity, and product size. A typical range of times for sausages is however 5 to 30 minutes. After drying the product is preferably chilled to reduce the temperature below 10°C and then packed and stored for sale.

In the coating or casting itself, the salt content of a salt-bath set product is generally about 4% to 7% after the extrusion and about 3% to 4% after 48 hours equilibration, when the salt has migrated into the foodstuff. The pH after extrusion of an acid swollen dough, for example a pH 3 dough, is generally about 4.2 to 4.7 after extrusion into an ammonia/brine bath, rising after equilibration to, for example, 5 to 6.4.

Plant suitable for carrying out the process of the invention in the case of the production of sausages is described by way of example with reference to the accompanying drawings. In the drawings

Figure 1 is a diagrammatic plan view of the plant;

Figure 2 is a diagrammatic elevational view;

Figure 3 is a diagrammatic view of the crimper/cutter, and

Figure 4 is a section of the extruder used in the plant.

In the Figures, 1 is a constant-displacement metering pump for sausage meat fed by two sausage stuffers 2 of conventional type working in tandem through a change-over valve so that while one is filling the other is delivering and continuous extrusion can be maintained. The collagen dough is fed to the extruder by a further stuffer 3. The sausage meat and dough pass to the contra-rotating cone extruder described below.

In the extruder unit and its associated setting bath, 4 is the support and drive-motor stand of conventional construction and 5 is the actual setting bath in the bottom of which the extruder 6 is mounted. Brine is circulated to the setting bath by means not shown, to maintain the concentration of the salt.

The elongated sausage emerging from the setting bath passes over a wheel 7 to a conveyor 8 on which it is lightly held by the crimper/cutters described below. The conveyor allows draining of excess setting solution back into the bath and gives the setting solution a short further period to act on the casing before the sausages are actually separated and dropped onto the further conveyor 9. It is found, surprisingly, that the collagen coating closes round sufficiently at the ends of the individual sausages formed under the action of such a cutter and subsequent drying, to retain the meat and give a satisfactory product without any need for the conventional twist linking procedure hitherto employed. The collagen wasted in twist linking (about 8% of the total length of natural or artificial casing used) is saved and the production of the tough little bits of twist is avoided.

The conveyor 9, which is of conventional construction, passes through an air drier, in which the air is fed through separate hoods 10 of tapered overall shape but constant cross-section designed to give a uniform air flow over the belt and themselves fed with air by conventional motor-driven fans 11.

The crimper-cutter consists of two vee-formed members (12) and (13) sliding in fixed upper and lower guides (14) and (15). A number of assemblies are mounted by means of the guides on the conveyor 8, which is of twin chain construction, and the distance between the assemblies determines the length of each sausage. The elongated sausage leaving the wheel 7 is fed into the vee cut outs in the sliding members and the vees slowly close, under the action of two cams between which the conveyor passes and which act through followers (16) and (17). The vees displace the meat within the coating to form individual sausages with rounded ends until only a thin neck of the coating is remaining. The neck is then cut, to separate individual sausages, by a knife (18) moving forward under the action of another cam on a roller

19 and slotted arm 20. Alternatively the sliding vee members may shear the skin.

The extruder as shown in Figure 3 has a 45° outer cone 21 carried in ultra-high precision bearings 22 in the head 23, which is screw-threaded for mounting in the bottom of the coagulating or setting bath. The inner cone 24 is carried within the outer one on further bearings 25. The members of the extrusion die are constituted by the two cones, the gap between them being 20 thousandths of an inch (0.48 mm.). A seal 126 is provided between the inner and outer cones and prevents escape of dough from a dough annulus 27 which feeds the gap 28 between the cones. The dough annulus is itself fed, through channels 29 in the outer cone, from a stationary feed annulus 30 which surrounds the cone and is sealed against it by seals 31. Concentric extensions 32, 33 of the cones take belt drives. Through the centre of the inner cone and its drive extension passes a bore 34. This bore takes a fixed tube 35 for the sausage meat, 0.75 in (1.9 cm.) diameter, clamped to a flange 36 by a coupling (not shown) on the supply line for the meat. A seal 37 is provided to prevent any escape of the setting solution.

In using the plant the collagen is first started extruding and the setting bath is then filled, the die parts being thus protected from blocking by set collagen. When extrusion of collagen is going smoothly the sausage meat is started and as soon as an even product is emerging the conveyor 8 is brought into action and the product fed to it. Operation is then automatic. Shutting down is the reverse.

The plant produces a product of very uniform weight. In a test run 33 consecutive nominal 1/2 lb. lots of sausages, dried, were weighed. The mean was 70 oz. 13 drams and the variation exceeded ± 1 dram in only five instances, four of ± 2 and one of ± 3 .

The invention is illustrated by the following Examples.

EXAMPLE 1

Green hides from 18 month steers were trimmed, halved, washed, clipped to remove hair, and then defleshed and split using standard tannery equipment, the grain layers being rejected. The flesh layers, average weight 12 kg. at 20% dry collagen solids, were cut into 6 inch (14 cm.) squares and steeped at 20°C for four hours in 50 litres of saturated sodium sulphate solution. The solution was then replaced by a similar solution containing additionally caustic soda adjusted to 1-N, which was allowed to act for 22 hours with periodic addition of flake caustic soda to maintain the normality of the solution. After the treatment the splits were washed three times for 10 minutes in water and then soaked for 1 1/2 days in 100 litres of hydrochloric acid solution, pH 4, containing 2.4 kg. com-

mon salt. After this time the splits were neutral at the centre. They were then washed, minced and milled the temperature being maintained at approximately 20°C. The resulting milled collagen was found to have a solids content of 8% and an extractability of 9.3 measured by the detailed method described herein, and was remilled six times after addition of 14 litres of 0.75% v/v aqueous glycerol to give a material of 5.6% solids content and 6% glycerol content. The glycerol is not essential.

The milled collagen was then converted to an acid-swollen dough of pH 3.05, apparent viscosity 68 poise, by passing it through an Oakes Mixer, 0.9 kg. of lactic acid being fed evenly into it by a metering pump as it passed to the mixer. The dough was finally deaerated into a Z-blade mixer under a reduced pressure of approximately 2.5 cm. of mercury and allowed to stand in chill for 36 hours.

A conventional English sausage meat mix was prepared from the following ingredients (parts by weight)

	parts	
Lean pork meat	15	90
Fat pork	15	
Rusk	4.7	95
Salt	0.57	
Skim milk powder	0.9	
Water	9	
Seasoning	0.1	

The skim milk and half the water were stirred together then added to the lean meat in a conventional bowl chopper. The mixture was chopped for three minutes, the salt and seasoning and the rest of the water being added as chopping commenced and the rusk and fat pork after two minutes.

Co-extrusion was then carried out as described above, the dough being supplied to the die at 125 p.s.i. (1.75 Kg./sq.cm.) at a feed rate to give 6.4 g./foot (21 g./metre). The extrusion rate was 25 ft./min. (12 cm./sec.) and the inner and outer cones of the die were contra-rotated at 70 and 85 r.p.m. respectively. The setting bath contained saturated salt brine N/10 with ammonia (pH 10), and was 12 inches (30 cm.) deep.

The sausage produced was 0.75 inches diameter (1.9 cm.) and was cut into 4 inch (10.2 cm.) lengths to give approximately 13 to the lb. (31 to the kg.) sausages. These were dried at an air flow rate of 2000 ft./min (10 m./sec.) with a residence time of 13 minutes, the temperature of the air being 23°C and the absolute humidity 0.0045.

The coating of the resulting sausages had a water content of 31.7% and after equilibration of salt and moisture content had been allowed to take place was of excellent appearance and quality. The water content of the coating after equilibration was 67.5%. Fig-

ures for pH were 4.5 before and 5.8 after equilibration, and for salt content 5.7% before and 3.6% after equilibration.

EXAMPLE 2

5 A collagen dough was prepared as in Example 1, having a viscosity of 70 poise.

The following beefburger mix was prepared:—

	lb.
10 90:10 lean beef	60
Beef fat	20
Rusk	3
Salt	1½
Seasoning	¾
15 Water and ice	14½

the lean beef being first minced and then chopped in a bowl chopper with successive additions of the water and ice, salt, seasoning rusk and fat, until evenly mixed.

20 Co-extrusion was then carried out in the plant described but using a die of 2" diameter with a tube of rectangular internal cross section in the bore. The extrusion speed was 14 feet/min., at a contrarotating die speed of 70 inner and 70 outer, and the bath being saturated common salt brine at pH 10 with ammonia, 12 inches deep. The burger emerged as a strip 1.5 inches×0.5 inches, and was cut into 3 inch lengths. These were dired at an air speed of 2000 ft./min, at a temperature of 20°C and absolute humidity of .007. Drying time 9 minus. Final casing moisture content was 28.7%.

35 The product cooked well with no splitting or sticking in the pan.

EXAMPLE 3

A co-extruded sausage was prepared as in Example 1 and the coating set as in that Example. After setting the product was washed for 1 1/2 minutes in N/10 aqueous ammonia to remove part of the salt, and then dipped for 10 seconds in a 3% weight/volume solution of di-aldehyde alginic acid. After drying as described the coating was examined and was found to be of improved strength and appearance compared with an untanned coating.

50 In a further run the procedure was modified by drying the product after setting, then washing, treating with the di-aldehyde alginic acid and re-drying. Further improved results were obtained.

WHAT WE CLAIM IS:—

55 1. A process for the preparation of a collagen-coated food product in which a collagen dough is extruded in tubular form upon a foodstuff, one or both surfaces of the collagen being subjected during extrusion to frictional forces acting in a direction about the axis of extrusion.

2. A process according to claim 1, in which both surfaces of the collagen are subjected to frictional forces.

3. A process according to claim 1 or claim 2, in which the frictional forces are applied by relative rotational movement between inner and outer members of the die through which the collagen dough is being extruded.

4. A process according to claim 3, in which the inner and outer members of the die are rotated in opposite senses.

5. A process according to any preceding claim, in which the foodstuff is shaped to receive the collagen by extrusion simultaneously with the collagen.

6. A process according to claim 3 or claim 4, in which the foodstuff is extruded through an axial bore in the inner member of the die.

7. A process according to claim 6, in which the bore is of substantially the same cross section as the coated food product being prepared.

8. A process according to claim 6 or claim 7, in which the foodstuff is kept from contact with the inner member of the die by provision within the bore of a stationary tube for passage of the foodstuff.

9. A process according to any preceding claim, in which the foodstuff is divided in portions before any air-drying of the coating.

10. A process according to any preceding claim, in which the collagen coating is set by contacting it with a salt-containing setting solution and subsequently dried in the presence of salt taken up from the solution.

11. A process according to any preceding claim, in which after setting the collagen coating is tanned.

12. A process according to Claim 11, in which the coating is tanned with a dialdehyde polysaccharide.

13. A process according to claim 12, in which the polysaccharide is dialdehyde alginic acid.

14. A process according to any preceding claim, in which the collagen dough is an acid-swollen dough.

15. A process according to any preceding claim, in which the viscosity of the collagen dough is 45—90 poise.

16. A process according to Claim 15, in which the viscosity is 60—70 poise.

17. A process according to any preceding claim, in which the dough contains 4.3 to 7.4% collagen on a dry weight basis.

18. A process according to Claim 17, in which the collagen content is 5.2 to 5.8%.

19. A process according to any preceding claim, in which the extractability of the collagen from which the dough is prepared is 7.16.

20. A process according to any preceding claim, in which after setting the product is dried to give a moisture content of the

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70

75

80

85

90

95

100

105

110

115

120

125

- coating on a dry weight basis on completion of the drying of at most 50%.
21. A process according to claim 20, in which the product is dried for 5—30 minutes in an air stream of absolute humidity not exceeding 0.012 at a temperature not exceeding 45°C.
22. A process according to any preceding claim, in which the coating is set by contacting it with a sodium chloride brine of 50—100% saturation.
23. A process according to Claim 22 in which the dough is an acid swollen dough and the brine contains ammonia.
24. A process according to claim 23, in which the pH of the coating as it leaves the setting solution is 4.2—4.7.
25. A process according to any one of Claims 22 to 24, in which the salt content of the coating is 4.7% by weight as it leaves the setting solution.
26. A process according to any preceding claim, in which the collagen dough is extruded at 10 to 25 thousandths of an inch (0.25 to 0.60 mm.) thickness.
27. A process according to claim 26, in which the thickness is 15 to 20 thousandths of an inch (0.35 to 0.5 mm).
28. A process according to any preceding claim, in which the collagen dough is extruded between die members between which there is relative rotation at 120 to 240 r.p.m.
29. A process according to any preceding claim, in which the speed of extrusion is up to 100 feet/minute.
30. A process according to Claim 29, in which the speed is up to 40 feet/minute.
31. A process according to any preceding claim, in which the foodstuff is sausage meat.
32. A process for the preparation of a collagen-coated food product substantially as hereinbefore described in Example 1.
33. A process for the preparation of a collagen-coated food product, substantially as described in Example 2 or Example 3.
34. A coextruded collagen-coated food product whose collagen coating has the property that the collagen fibres adjacent one surface of the coating are oriented in one direction and the collagen fibres adjacent the other surface of the coating are oriented in another direction, the angle between the two said directions in the direction of the axis of extrusion being from 30° to 120°.
35. A collagen-coated food product prepared by the process of any one of Claims 1 to 33.
36. A sausage prepared by a process according to claim 31.

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